METHOD AND APPARATUS FOR SOLVING SYSTEMS OF NONLINEAR EQUATIONS USING INTERVAL ARITHMETIC

ABSTRACT

One embodiment of the present invention provides a computerbased system for solving a system of nonlinear equations specified by a vector function, f, wherein $f(\mathbf{x}) = \mathbf{0}$ represents $f_1(\mathbf{x}) = 0$, $f_2(\mathbf{x}) = 0$, $f_3(\mathbf{x}) = 0$, ..., $f_n(\mathbf{x}) = 0$. wherein x is a vector $(x_1, x_2, x_3, \dots x_n)$. The system operates by receiving a representation of a subbox $X = (X_1, X_2, ..., X_n)$, wherein for each dimension, i, the representation of X_i includes a first floating-point number, a_i , representing the left endpoint of X_i , and a second floating-point number, b_i , representing the right endpoint of X_t . The system stores the representation in a computer memory. Next, the system applies term consistency to the set of nonlinear equations, $f_1(\mathbf{x}) = 0$, $f_2(\mathbf{x}) = 0$, $f_3(\mathbf{x}) = 0$, ..., $f_n(\mathbf{x}) = 0$, over **X**, and excludes portions of **X** that violate the set of nonlinear equations. The system also applies box consistency to the set of nonlinear equations over X, and excludes portions of X that violate the set of nonlinear equations. Finally, the system performs an interval Newton step on X to produce a resulting subbox Y, wherein the point of expansion of the interval Newton step is a point x within X, and wherein performing the interval Newton step involves evaluating f(x) using interval arithmetic to produce an interval result $f^{I}(x)$. The system integrates the sub-parts of the process with branch tests designed to increase the overall speed of the process.